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(54) **ARMORED CABLE WITH INTEGRAL SUPPORT**

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CPC ***H01B 7/0009*** (2013.01); ***H01B 7/184*** (2013.01); ***H01B 9/028*** (2013.01); *H01B 7/04* (2013.01); *H01B 7/1895* (2013.01)

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See application file for complete search history.

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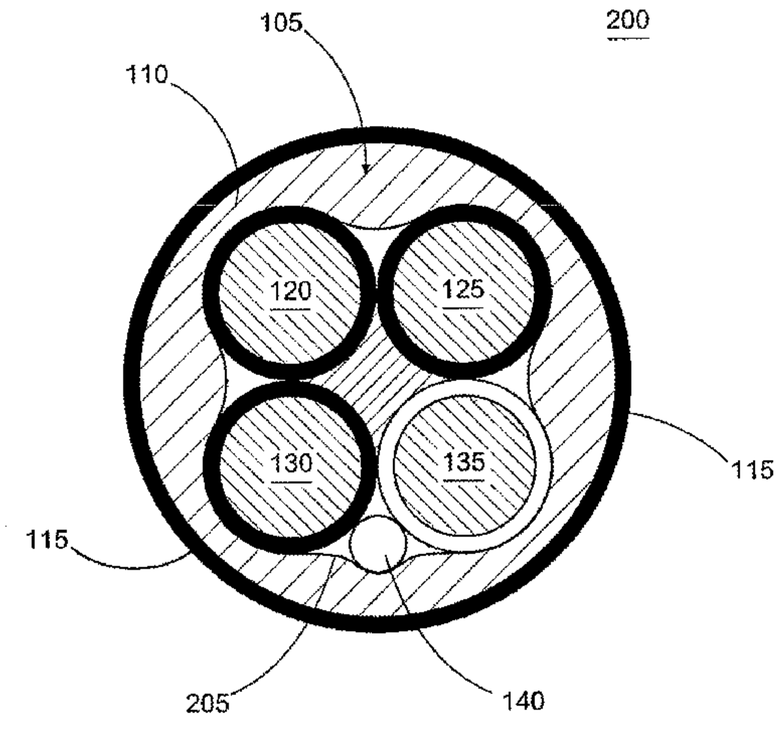
(57) **ABSTRACT**

A system for providing cable support may be provided. The system may comprise a conductor core, a filler that may provide integral core support, and armor. The conductor core may comprise at least one conductor. The filler may be applied around at least a portion of the conductor core. The armor may be applied around at least a portion of the filler. The applied armor may be configured to cause the filler to apply a strong enough force on an exterior of the conductor core configured to keep the conductor core from slipping down an interior of the filler due to a gravitational force. In addition, the applied armor may be configured to cause the filler to apply a strong enough force on an interior of the armor configured to keep a combination of the conductor core and the filler from slipping down the interior of the armor due to the gravitational force.

20 Claims, 5 Drawing Sheets



(51) **Int. Cl.**

H01B 7/18	(2006.01)
H01B 9/02	(2006.01)
H01B 7/04	(2006.01)

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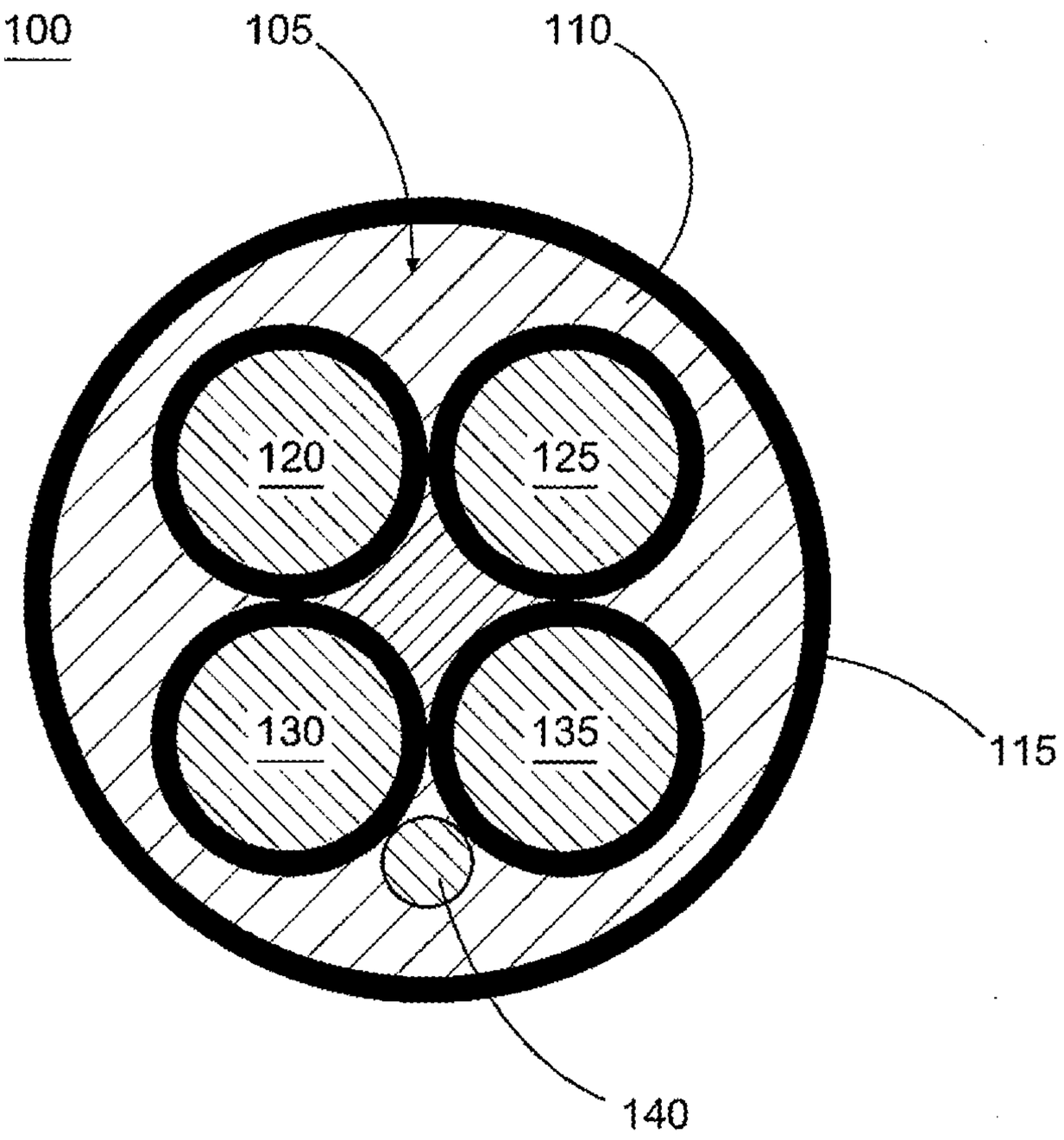

FIG. 1

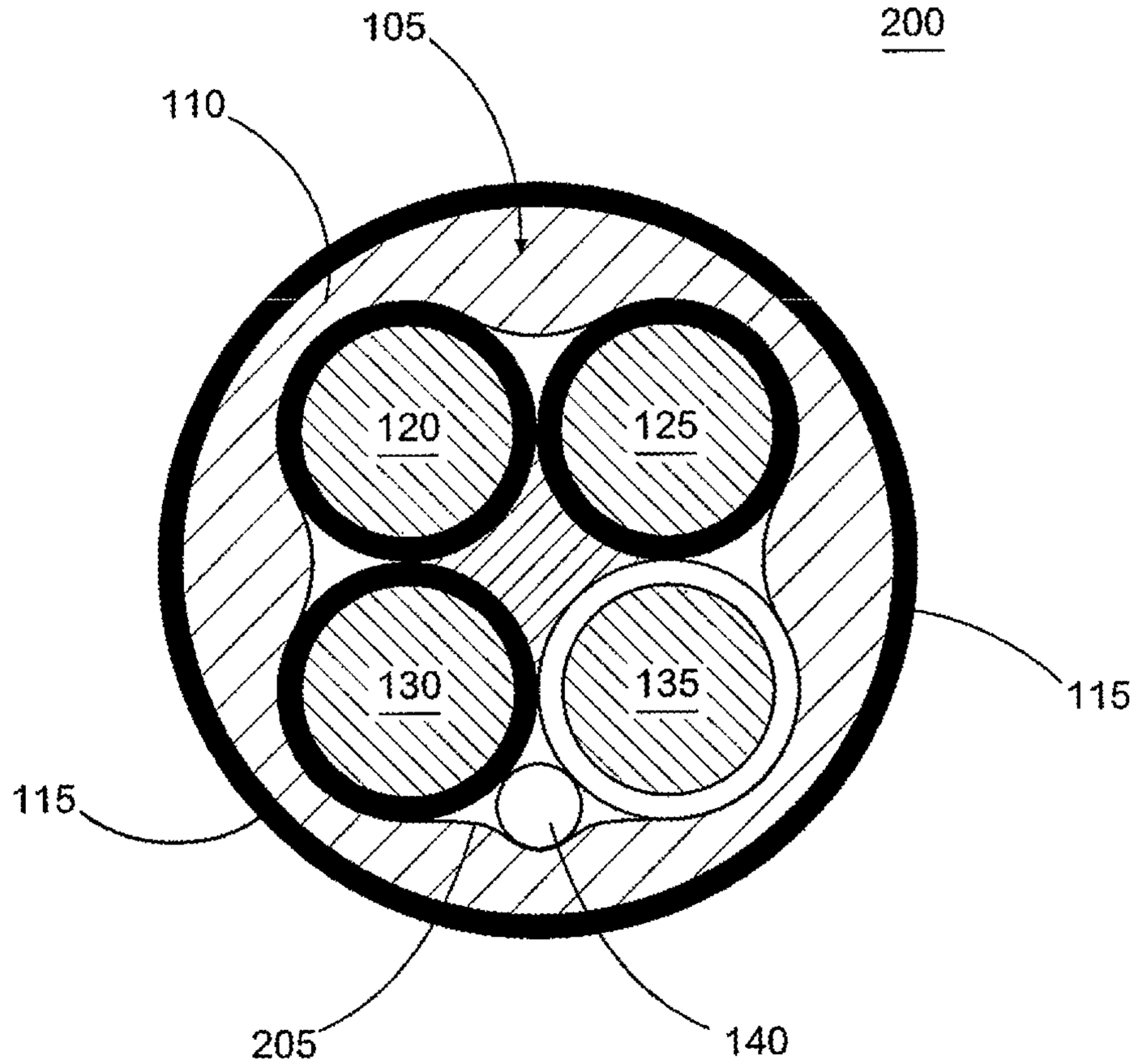

FIG. 2

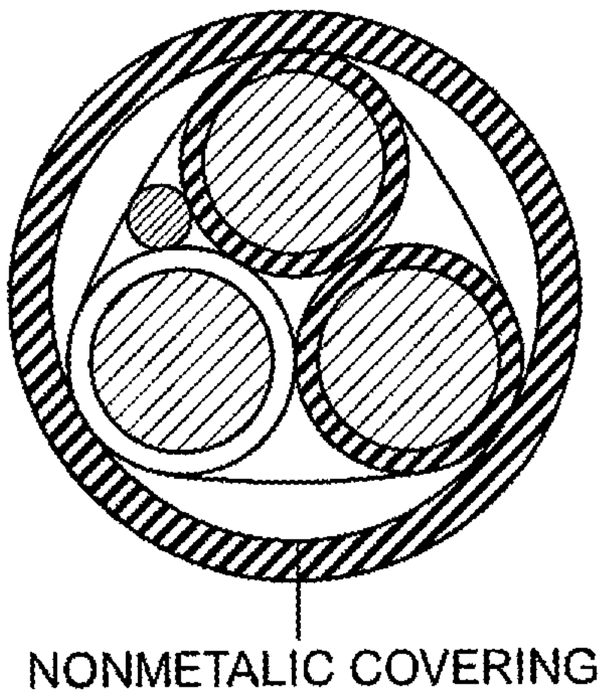
NONMETALIC COVERING

FIG. 3

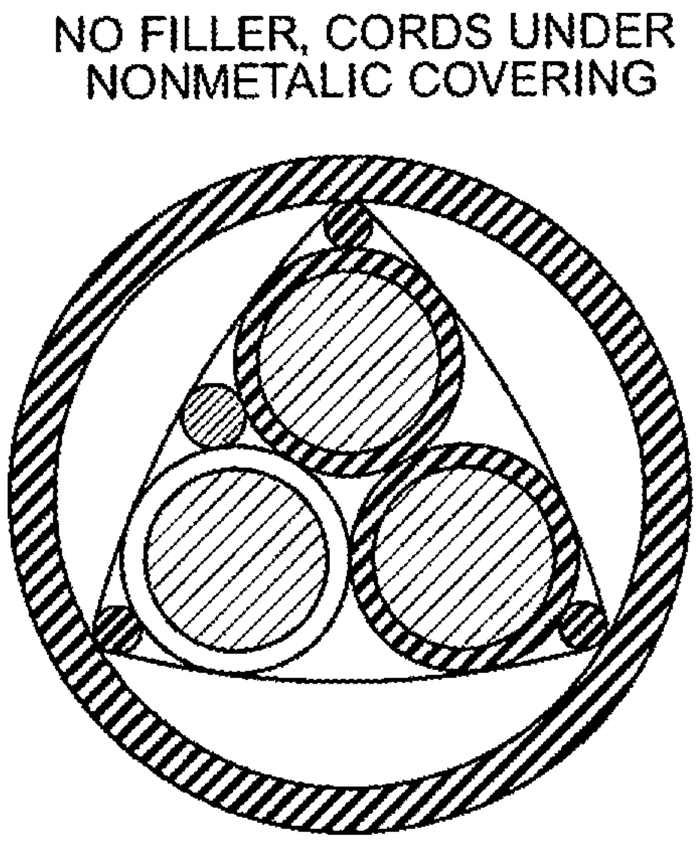
NO FILLER, CORDS UNDER
NONMETALIC COVERING

FIG. 4

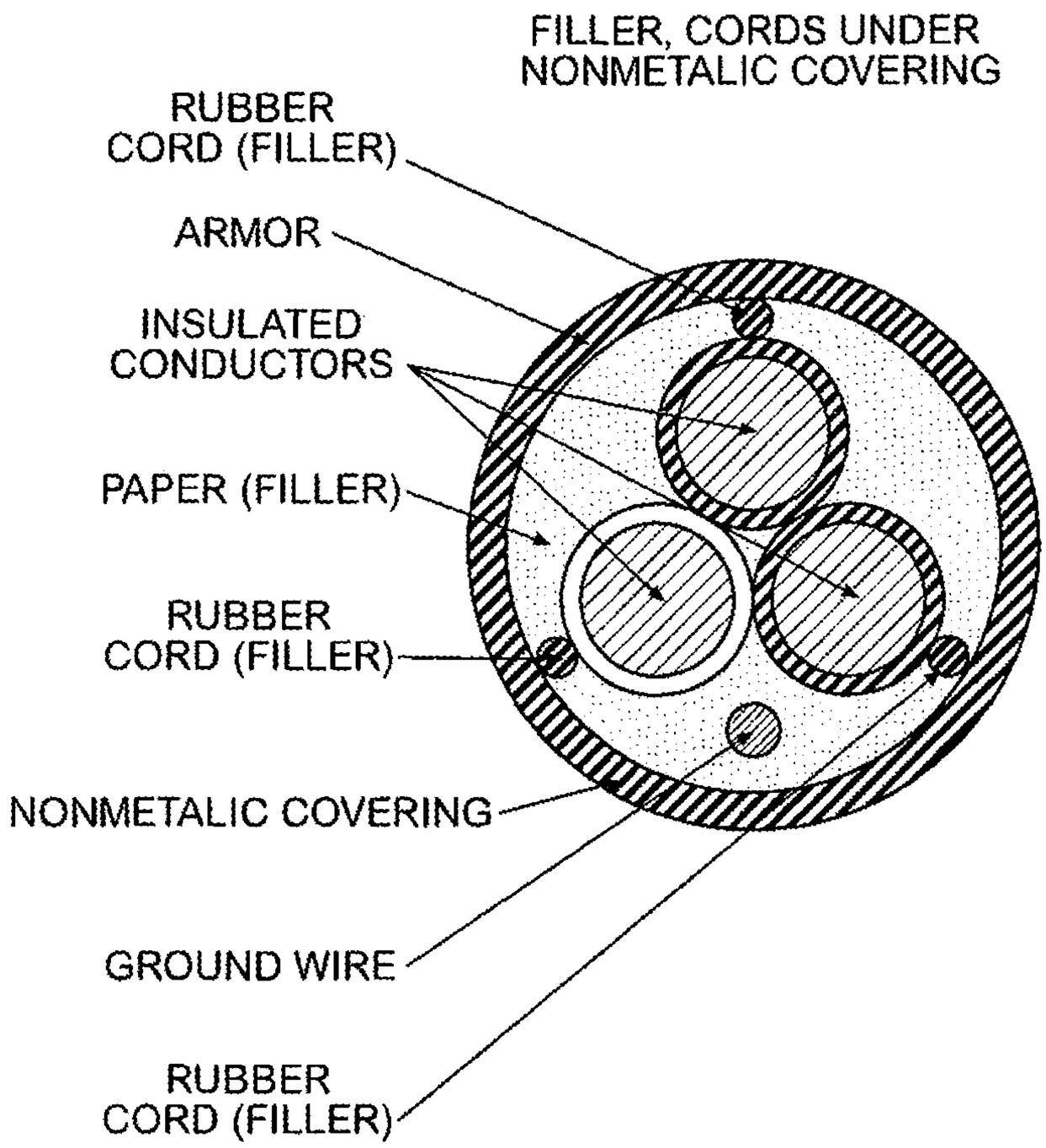
FILLER, CORDS UNDER NONMETALIC COVERING
RUBBER CORD (FILLER)
ARMOR
INSULATED CONDUCTORS
PAPER (FILLER)
RUBBER CORD (FILLER)
NONMETALIC COVERING
GROUND WIRE
RUBBER CORD (FILLER)

FIG. 5

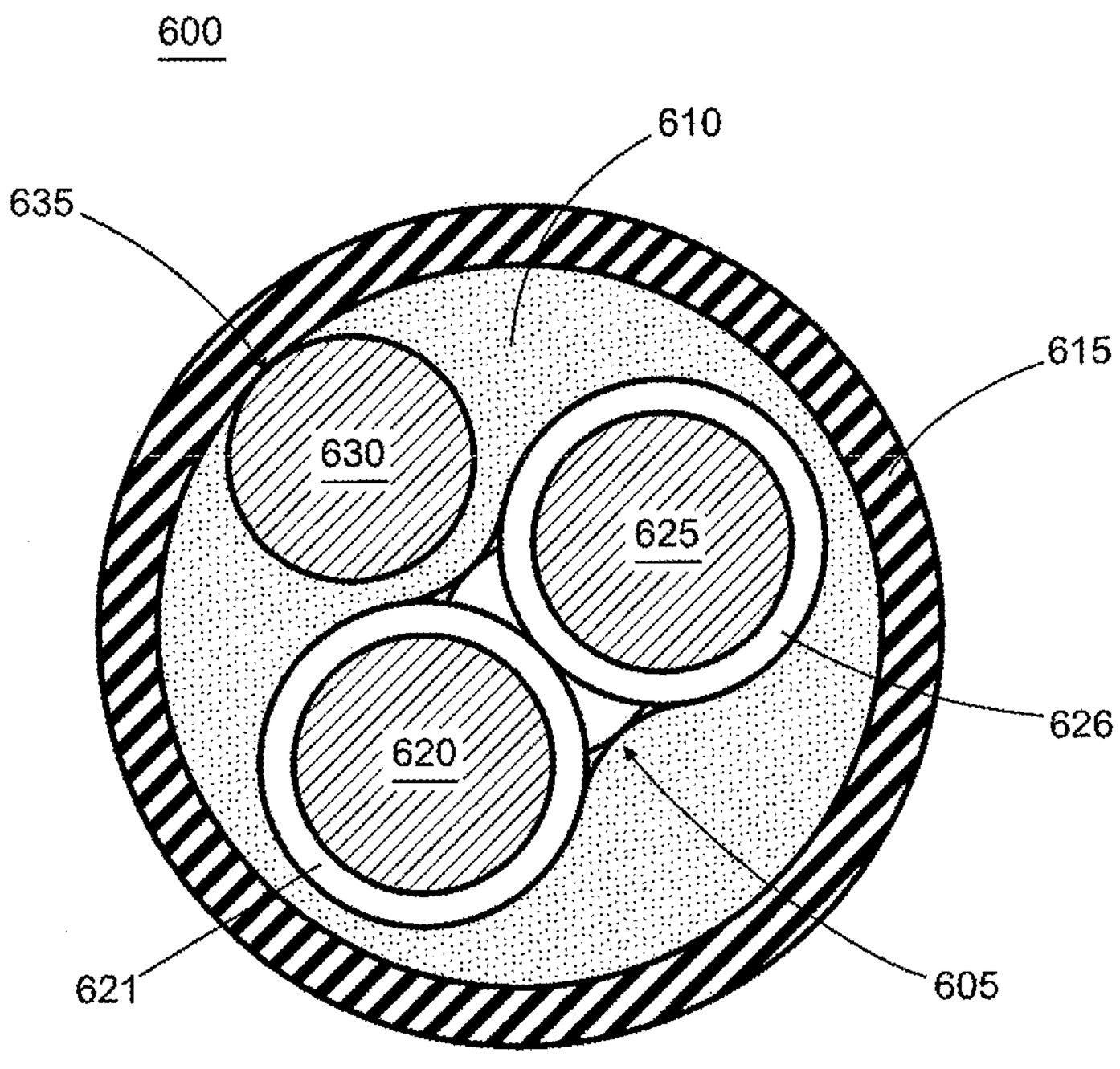

FIG. 6

ARMORED CABLE WITH INTEGRAL SUPPORT

REFERENCE TO RELATED APPLICATIONS

This application is a continuation application of U.S. patent application Ser. No. 12/814,595, filed on Jun. 14, 2010, now U.S. Pat. No. 8,697,996, which is a continuation application of U.S. patent application Ser. No. 12/046,488, filed on Mar. 12, 2008, now U.S. Pat. No. 7,754,969, which claims the benefit of U.S. Provisional Application No. 60/942,727, filed on Jun. 8, 2007, the disclosures of which are incorporated herein by reference in their entirety.

BACKGROUND

Cable risers are used to supply power, for example, to multi-story building such as apartments or condominiums. For example, conductors may be placed in a vertical raceway and run to individual apartments. In some situations, due to gravitational forces, conductors within the vertical raceways may slip down the armor. For example, to stop this cable slippage, offsets may be used. Thus, the conventional strategy is to create horizontal offsets in the vertical raceway runs to stop slippage. This often causes problems because conventional systems create significant costs and time requirements for installing cable risers. In view of the foregoing, there is a need for methods and systems for providing vertical cable and raceways more optimally. Furthermore, there is a need for providing cable raceways with integral (i.e. built-in) support.

SUMMARY

A system for providing cable support may be provided. The system may comprise a conductor core, a filler that may provide integral core support, and armor. The conductor core may comprise at least one conductor. The filler may be applied around at least a portion of the conductor core. The armor may be applied around at least a portion of the filler. The filler may apply a strong enough force on an exterior of the conductor core configured to keep the conductor core from slipping down an interior of the filler due to a gravitational force. In addition, the filler may apply a strong enough force on an interior of the armor configured to keep a combination of the conductor core and the filler from slipping down the interior of the armor due to the gravitational force.

It is to be understood that both the foregoing general description and the following detailed description are examples and explanatory only, and should not be considered to restrict the invention's scope, as described and claimed. Further, features and/or variations may be provided in addition to those set forth herein. For example, embodiments of the invention may be directed to various combinations and sub-combinations described in the detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated in and constitute a part of this disclosure, illustrate various embodiments of the present invention. In the drawings:

FIG. **1** is a diagram of an armored cable system with integral support;

FIG. **2** is a diagram of an armored cable system with integral support and tape separator;

FIG. **3** is a diagram of an armored cable system using different fillers and rubber cord configurations;

FIG. **4** is a diagram of an armored cable system using different fillers and rubber cord configurations;

FIG. **5** is a diagram of an armored cable system using different fillers and rubber cord configurations; and

FIG. **6** is a diagram of an armored cable system with grounded armor.

DETAILED DESCRIPTION

The following detailed description refers to the accompanying drawings. Wherever possible, the same reference numbers are used in the drawings and the following description to refer to the same or similar elements. While embodiments of the invention may be described, modifications, adaptations, and other implementations are possible. For example, substitutions, additions, or modifications may be made to the elements illustrated in the drawings, and the methods described herein may be modified by substituting, reordering, or adding stages to the disclosed methods. Accordingly, the following detailed description does not limit the invention.

Consistent with embodiments of the invention, an armored cable with integral support may be provided. Embodiments of the invention may eliminate conventional cable offsets in vertical raceway cable installations by providing integral support between conductors and the armor. Consequently, the integral support may keep the conductors within the armor in a vertical raceway installation from slipping down due to gravitational forces. Accordingly, embodiments of the invention may reduce cable installation time and cost.

FIG. **1** shows a diagram of an armored cable system **100** with integral support. FIG. **1** shows a cross-section of system **100**, which may have a longitudinal length. As shown in FIG. **1**, system **100** may include a conductor core **105**, a filler **110**, and an armor **115**. Conductor core **105**, though not so limited, may comprise a first conductor **120**, a second conductor **125**, a third conductor **130**, a fourth conductor **135**, and a ground wire **140**. Fourth conductor **135** may be configured to be used as a neutral (e.g. may have an insulation color designating it as a neutral or may be of a different size than the other conductors in conductor core **105**).

While as shown in FIG. **1**, conductor core **105** includes four conductors and a neutral, embodiments of the invention are not so limited. For example, conductor core **105** may include any number of conductors (e.g. insulated, non-insulated, or otherwise) and may include any number of ground wires or may not include a ground wire. Any one or more of the conductors in conductor core **105** may be configured to be a neutral wire, or none of the conductors in conductor core **105** may be configured to be a neutral wire. Any one or more of the conductors or ground wire(s) in conductor core **105** may have an insulation color indicating that any one or more of the conductors or ground wire(s) in conductor core **105** is intended as a neutral(s). Furthermore, the conductors or ground wire(s) in conductor core **105** may all be the same size or they may vary individually or in any sub-combination by size. In addition, the conductors or ground wire(s) in conductor core **105** may all be made of the same material (e.g. copper, aluminum, etc.) or they may vary individually or in any sub-combination by material. Also, the conductors or ground wire(s) in conductor core **105** may all be stranded or solid or they may vary individually or in any sub-combination by being stranded or solid. Notwithstanding, conductor core **105** may comprise any conductor construction.

Filler **110** may comprise, but is not limited to, polyethylene, polyvinyl chloride (PVC), or nylon. A foaming agent, a material comprising micro-spheres, or other similar substances may be added to filler **110** before filler **110** is extruded

onto conductor core **105**. The foaming agent may be configured to create voids in filler **110**. When filler **110** is compressed in a first direction (e.g. toward the center of system **100**,) the voids (or micro-spheres) in filler **110** may tend to create an opposing force in filler **110** opposite the first direction. For example, after being extruded onto conductor core **105**, filler **110** may have a "squeezing" force applied to its exterior by armor **115**. With this squeezing force applied to filler **110**, the voids (or micro-spheres) in filler **110** may be configured to cause filler **110** to: i) apply a strong enough force on the exterior of conductor core **105** to keep conductor core **105** from slipping down filler **110**'s interior due to gravitational forces on conductor core **105**; and ii) apply a strong enough force on armor **115**'s interior to keep the combination of conductor core **105** and filler **110** from slipping down armor **115**'s interior due to the gravitational forces on conductor core **105** and filler **110**. As stated above, micro-spheres added to the filler **110** may cause an effect similar to the voids created by the foaming agent. The micro-spheres may tend to be more evenly distributed in filler **110** than the voids.

Filler **110** may comprise, but is not limited to, a flexible PVC compound (e.g. SW1005) with 0.1% to 5% HC-01 foaming agent by weight. The foaming agent may be supplied by Bayer Corporation of 100 Bayer Road, Pittsburgh, Pa. 15205-9741. Furthermore, as stated above, micro-spheres may be combined with the flexible PVC compound instead of the foaming agent for example. The micro-spheres may comprise Expancel micro-spheres 930 MB 120 supplied by Expancel-AKZO NOBEL of 2240 Northmont Parkway, Duluth, Ga. 30096. The formulation using micro-spheres may comprise 0.5% 930 MB 120 to 99.5% SW1005 by weight. The range of Expancel micro-spheres used may vary, for example, between 0.1% and 5% by weight.

Notwithstanding, filler **110** may comprise or be augmented with any substance that (when filler **110** is squeezed) is, for example, capable of: i) applying a strong enough force on the exterior of conductor core **105** to keep conductor core **105** from sliding down filler **110**'s interior due to gravitational forces on conductor core **105**; and ii) applying a strong enough force on the interior of armor **115** to keep the combination of conductor core **105** and filler **110** from slipping down armor **115**'s interior due to gravitational forces on conductor core **105** and filler **110**.

Armor **115** may comprise any substance (e.g. metallic, non-metallic, electrically conductive, electrically semi-conductive, etc.) or construction capable of creating the aforementioned "squeezing" force applied to filler **110**'s exterior. For example, armor **115** may comprise a continuous strip having a width and being applied helically around filler **110**. The continuous strip, for example, may be snuggly or tightly wrapped around filler **110**. The continuous strip (e.g. metallic or non-metallic) may have a concave side facing filler **110**. Concavities in the concave side may tend to be filled by portions of filler **110** when armor **115** squeezes filler **110**. This concavity filling may aid filler **110** in applying the aforementioned force strong enough on the interior of the armor **115** to keep the combination of conductor core **105** and filler **110** from slipping down armor **115**'s interior due to gravitational forces on conductor core **105** and filler **110**. Armor **115** may be, but is not limited to, welded corrugations or other assembly construction such as interlocked strip or braided stranding for example.

Consistent with embodiments of the invention, armored cable system **100** may be used in cable risers used to supply power, for example, to multi-story building such as apartments or condominiums. For example, armored cable system **100** may be placed in a substantially vertical raceway and run to individual apartments. Due to gravitational forces, conventional conductors within the vertical raceways may slip down the armor. However, consistent with embodiments of the invention, gravitational forces may not cause conductor core **105** to slip down armor **115** because armored cable system **100** may include integral support. This may be true even when armored cable system **100** (and thus conductor core **105**) is in a substantial vertical altitude or position. This integral support may be created by filler **110** being "squeezed" by armor **115**. With this squeezing force applied to filler **110**, voids or micro-spheres in filler **110** may be configured to cause filler **110** to: i) apply a strong enough force on the exterior of conductor core **105** to keep conductor core **105** from slipping down filler **110**'s interior due to gravitational forces on conductor core **105**; and ii) apply a strong enough force on armor **115**'s interior to keep the combination of conductor core **105** and filler **110** from slipping down armor **115**'s interior due to gravitational forces on conductor core **105** and filler **110**.

FIG. **2** shows a diagram of a cable system **200** with integral support and tape separator. As shown in FIG. **2**, system **200** may include the same elements of system **100** as described above; however, system **200** may include the addition of a tape separator **205**. Tape separator **205** may be non-metallic. Notwithstanding tape separator **205**, system **200** may be constructed and may function in ways similar to system **100**. FIGS. **3** through **5** show other embodiments using different fillers and rubber cord configurations.

FIG. **6** shows a diagram of an armored cable system **600** with grounded armor consistent with embodiments of the invention. System **600** may be used, for example, in applications where electrical codes may require a cable's armor to be well grounded such as in a medical or critical care environment. As shown in FIG. **6**, system **600** may include a conductor core **605**, a filler **610**, an armor **615**, and a ground wire **630**. FIG. **6** shows a cross-section of system **600**, which may have a longitudinal length. For example, ground wire **630** may be placed between filler **610** and armor **615** where ground wire **630** and armor **615** come into electrical contact at a point **635**, for example, as described in more detail below.

Conductor core **605**, though not so limited, may comprise a first conductor **620** and a second conductor **625**. First conductor **620** and second conductor **625** may respectively include insulation layer **621** and insulation layer **626**. Notwithstanding, conductor core **605** may include more or less conductors compared to the example shown in FIG. **6**. In addition, system **600** may include more or less ground wires compared to the example shown in FIG. **6**. Conductor core **605** may be of similar construction as conductor code **105** as described above. However, conductor core **605** may or may not include a ground wire or neutral wire. Similarly, conductor **620** and conductor **625** may be of the same construction as conductor **120** and conductor **125** respectively as described above and ground wire **630** may be of the same construction as ground wire **140** as described above. Moreover, filler **610** and armor **615** may be of similar construction to filler **110** and armor **115** respectively as described above.

Armor **615** may comprise any substance (e.g. metallic, non-metallic, electrically conductive, electrically semi-conductive, etc.) or construction capable of creating a "squeezing" force applied to filler **610**'s exterior. For example, armor **615** may comprise a continuous strip having a width and being applied helically around filler **610**. The continuous strip, for example, may be snuggly or tightly wrapped around filler **610**. The continuous strip may have a concave side facing filler **610**. Concavities in the concave side facing filler **610** may tend to be filled by portions of filler **610** when armor **615** squeezes filler **610**. As described in more detail below,

when the aforementioned squeezing force is applied to filler **610** by armor **615**, voids (or micro-spheres) in filler **610** may cause filler **610** to apply a strong enough force to ground wire **630** to create an electrical connection between ground wire **630** and armor **615** at point **635**, for example.

As described above with respect to FIG. **6**, filler **610** may comprise, but is not limited to, polyethylene, polyvinyl chloride (PVC), or nylon. A foaming agent or a material comprising micro-spheres may be added to filler **610** before filler **610** is extruded onto conductor core **605**. (Examples of the types and amounts of foaming agent and micro-spheres are described above with respect to filler **110**.) The foaming agent may be configured to create voids in filler **610**. Notwithstanding, filler **610** may comprise or be augmented with any substance that may be capable of causing filler **610** to apply a strong enough force to ground wire **630** to create an electrical connection between ground wire **630** and armor **615**.

Consistent with embodiments of the invention, when filler **610** is compressed (e.g. squeezed by armor **615** or otherwise compressed within armor **615**) in a first direction (e.g. toward the center of system **600**,) the voids (or micro-spheres) in filler **610** may tend to create an opposing force in filler **610** opposite the first direction. For example, after being extruded onto conductor core **605**, filler **610** may have a squeezing force applied to its exterior by armor **615**. With this squeezing force applied to filler **610** (e.g. toward the center of system **600**,) the voids (or micro-spheres) in filler **610** may tend to create an opposing force in filler **610** opposite the first direction. Consequently, this opposing force may cause filler **610** to apply a strong enough force to ground wire **630** to create an electrical connection between ground wire **630** and armor **615**. In other words, armor **615** may press against ground wire **630** on one side of ground wire **630** and filler **610** may press against ground wire **630** on a side opposing armor **615**. Accordingly, ground wire **630** may snuggly contact armor **615** at at least point **635**. Moreover, ground wire **630** may snuggly contact armor **615** at any number of points along system **600**'s longitudinal length and is not limited to contacting armor **615** at only point **635**. In addition, ground wire **630** may contact armor **615** continuously along system **600**'s longitudinal length. When ground wire **630** and armor **615** are both electrically conductive (e.g. both being bare and metallic,) the aforementioned contact between ground wire **630** and armor **615** may create an electrical connection between ground wire **630** and armor **615**.

Consistent with embodiments of the invention, filler **110** or filler **610** may be applied to conductor core **105** or conductor core **605** respectively in any manner and there application is not limited to extrusion. Furthermore, forces caused by filler **110** or filler **610** are not limited to being created by applying armor **115** or armor **615** to squeeze filler **110** or filler **610** respectively. These forces created in filler **110** or filler **610** may be created in any way. In addition, filler **110** and filler **610** may respectively electrically insulate conductor core **105** and conductor core **605** from armor **115** and armor **615**. Furthermore, the construction of system **100** or system **600** is not limited to any sequence and the elements that make up system **100** or system **600** can be applied in any sequence.

While certain embodiments of the invention have been described, other embodiments may exist. Further, the disclosed methods' stages may be modified in any manner, including by reordering stages and/or inserting or deleting stages, without departing from the invention.

While the specification includes examples, the invention's scope is indicated by the following claims. Furthermore, while the specification has been described in language specific to structural features and/or methodological acts, the claims are not limited to the features or acts described above. Rather, the specific features and acts described above are disclosed as example for embodiments of the invention.

What is claimed is:

1. A cable comprising:
- a conductor core comprising at least three conductors and at least one ground wire,
  - wherein the at least one ground wire is adjacent at least one of the at least three conductors;
- a filler around the conductor core,
  - the filler comprising micro-spheres and a polyvinyl chloride; and
- an electrically conductive armor around the filler,
  - the armor comprising a concave side facing the filler, wherein portions of the filler fill concavities created by the concave side.

2. The cable of claim **1**, wherein at least one of the at least three conductors is an insulated conductor.

3. The cable of claim **1**, wherein the at least three conductors are insulated conductors.

4. The cable of claim **3**, wherein the amount of micro-spheres is between 0.1% and 5% based on the total weight of the filler.

5. The cable of claim **1**, wherein the armor is free of a jacket on an exterior of the armor.

6. The cable of claim **1**, wherein the armor comprises a continuous strip applied helically around the filler.

7. The cable of claim **1**, wherein the armor comprises interlocked strips applied around the filler.

8. The cable of claim **1**, wherein the armor is configured to cause the filler to:
- apply a strong enough force on an exterior of the conductor core configured to keep the conductor core from slipping down an interior of the filler due to a gravitational force on the conductor core when the cable is in a substantial vertical altitude; and
- apply a strong enough force on an interior of the armor configured to keep a combination of the conductor core and the filler from slipping down the interior of the armor due to the gravitational force on the conductor core and a gravitational force on the filler.

9. A cable comprising:
- a conductor core comprising two or more conductors and at least one ground wire,
  - wherein the at least one ground wire is adjacent at least one of the two or more conductors;
- a filler around the conductor core,
  - the filler comprising micro-spheres and a polyethylene, a polyvinyl chloride, or a nylon; and
- an electrically conductive armor around the filler,
  - the armor comprising a concave side facing the filler, wherein portions of the filler fill concavities created by the concave side.

10. The cable of claim **9**, wherein the filler comprises micro-spheres and polyethylene.

11. The cable of claim **9**, wherein the filler comprises micro-spheres and polyvinyl chloride.

12. The cable of claim **9**, wherein the amount of micro-spheres is between 0.1% and 5% based on the total weight of the filler.

13. The cable of claim **9**, wherein the armor is configured to cause the filler to:
- apply a strong enough force on an exterior of the conductor core configured to keep the conductor core from slipping down an interior of the filler due to a gravitational force on the conductor core when the cable is in a substantial vertical altitude; and

apply a strong enough force on an interior of the armor configured to keep a combination of the conductor core and the filler from slipping down the interior of the armor due to the gravitational force on the conductor core and a gravitational force on the filler.

14. The cable of claim **9**, wherein the armor is free of a jacket on an exterior of the armor.

15. The cable of claim **9**, wherein the armor comprises a continuous strip applied helically around the filler.

16. The cable of claim **9**, wherein at least one of the conductors is an insulated conductor.

17. A cable comprising:

a conductor core comprising two or more conductors and at least one ground wire,

wherein the at least one ground wire is adjacent at least one of the two or more conductors;

a filler around at least a portion of the conductor core,

the filler comprising a foamed polyethylene, a foamed polyvinyl chloride, or a foamed nylon; and

an electrically conductive armor around the filler,

the armor comprising a concave side facing the filler, wherein portions of the filler fill concavities created by the concave side.

18. The cable of claim **17**, wherein the filler comprises foamed polyvinyl chloride.

19. The cable of claim **17**, wherein the armor is free of a jacket on an exterior of the armor.

20. The cable of claim **17**, wherein at least one of the conductors is an insulated conductor.

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